SECTION 4: SAFETY ISSUES

4.1 General

This section discusses the safety issues encountered both during the initial desktop study and the nine site inspections of seal extension projects discussed in Section 1. It should be noted that some projects were up to five years old and practices observed may no longer be in use.

4.2 Horizontal Design

Horizontal design philosophy varied greatly between projects. Several RCA's did not provide, and possibly did not consider, the design speeds of horizontal curves. It was evident that the AUSTROADS approach which limits the difference in design speed between successive geometric elements to 10km/h (desirable) and 15km/h (absolute) was not applied. This approach is to ensure that drivers are not 'surprised' by sudden changes in design standards. It should be noted that straights are also considered to have design speeds.

Recommendations

That Transfund require all Road Controlling Authorities to adopt the AUSTROADS design philosophy described above.

That Transfund require sufficient curve design details be provided on the drawings to enable designs to be easily audited or peer reviewed.

4.3 Vertical Design

In many cases the vertical alignment appeared not to have been adequately considered. Either it was arbitrarily concluded that improvements were not required or the associated costs were considered to be prohibitive. In some cases the project economics predicted a 20km/h increase travel speed, but no vertical alignment improvements were made.

Where the vertical alignment had not been upgraded to match the horizontal design speed, safety problems such as difficulty in reading the forward geometry and inadequate visibility to edge lines/centre lines were noted.

Recommendation

That Transfund require scheme assessments to adequately consider the proposed standard of the vertical alignment in relation to the horizontal alignment and the predicted travel speeds.

4.4 Superelevation

On some projects inspected there were isolated curves where the superelevation was considered inadequate. This may have been as a result of poor horizontal curve design as discussed previously, where many projects included curve designs without reference to design speeds.

In some cases the proposed superelevations were matched to the existing superelevations to minimise basecourse quantities, again with no reference made to design speeds. In one of these cases the design superelevations were rounded off to the nearest 2%.

There was also a concern that the inadequate superelevation may have been as a result of the weighting given by the designer to limiting the warp rate. This issue is discussed further under warp rates in Section 4.5.

Recommendations

That Transfund require all designs to comply with good practice/approved standards and guidelines. This issue is discussed further in Section 3.6: Standards.

4.5 Warp Rates

Warp rate is the rotation rate of superelevation development - normally presented as the percentage change in cross fall/second of travel at the curve design speed.

In many cases warp rates appeared not to have been considered and in others the AUSTROADS guideline of a maximum of 3.5%/sec up to 70km/h had been strictly adhered to. On one project the warp rates were in the order of 10%/sec.

In practice the warp rate is commonly a trade-off against maximum superelevation/curve radius. However, there is currently some debate within the profession as to what absolute limits should be applied.

It is thought that generally increasing superelevation at the cost of warp rates on the tightest curves should increase safety. However, there is an associated reduction in comfort and the effects of high warp rates in conjunction with steep vertical grades is unknown. It would appear that the AUSTROADS Guidelines on warp rates may not be appropriate for very low volume roads in difficult terrain.

Recommendation

Transfund undertake a review of the appropriateness of the AUSTROADS Guidelines on warp rates for New Zealand conditions.

4.6 Seal Width

The seal width (typical) on most projects was in the range 5.5m to 6.0m and generally not considered a safety problem. What was of most concern was the practice of achieving the additional seal width by steepening the feather edge slope. **This compromises both safety and the structural integrity of the seal edge and significantly increases future maintenance costs.** This issue is discussed further in Section 4.8: Feather Edge Slopes.

On some projects there were isolated sections where the seal width was reduced. These were of concern for a number of reasons:

- some sections of reduced width were relatively short and the cost of widening was not considered prohibitive.
- widths detailed on the construction drawings had not always been achieved.
- Project Information Sheets did not identify these reductions in seal width. This is likely to have occurred as a result of inadequate investigations or poor design.

It should be noted that the team is aware of other seal extensions which have an unsafe seal width over the full length of the project. However, this problem was not found on the projects selected at random.

The team has no specific recommendations regarding seal width. However, a number of other issues dealt with in this report are closely related and should be referred to: Section 3.3: Scheme assessments, Section 3.6: Standards and Section 4.8: Feather Edge Slopes.

4.7 Extra Widening

Most projects inspected included at least nominal extra widening on horizontal curves. However, it is likely on a significant number of curves that two large vehicles would not be able to pass. Although the probability of this occurring is low this was still considered a safety problem where there was insufficient sight distance to allow vehicles in opposing directions to see each other and stop safely. One vehicle can then wait while the other negotiates the curve.

Recommendation

That Transfund require all designs to comply with good practice/approved standards and guidelines. This issue was discussed in some detail in Section 3.6: Standards.

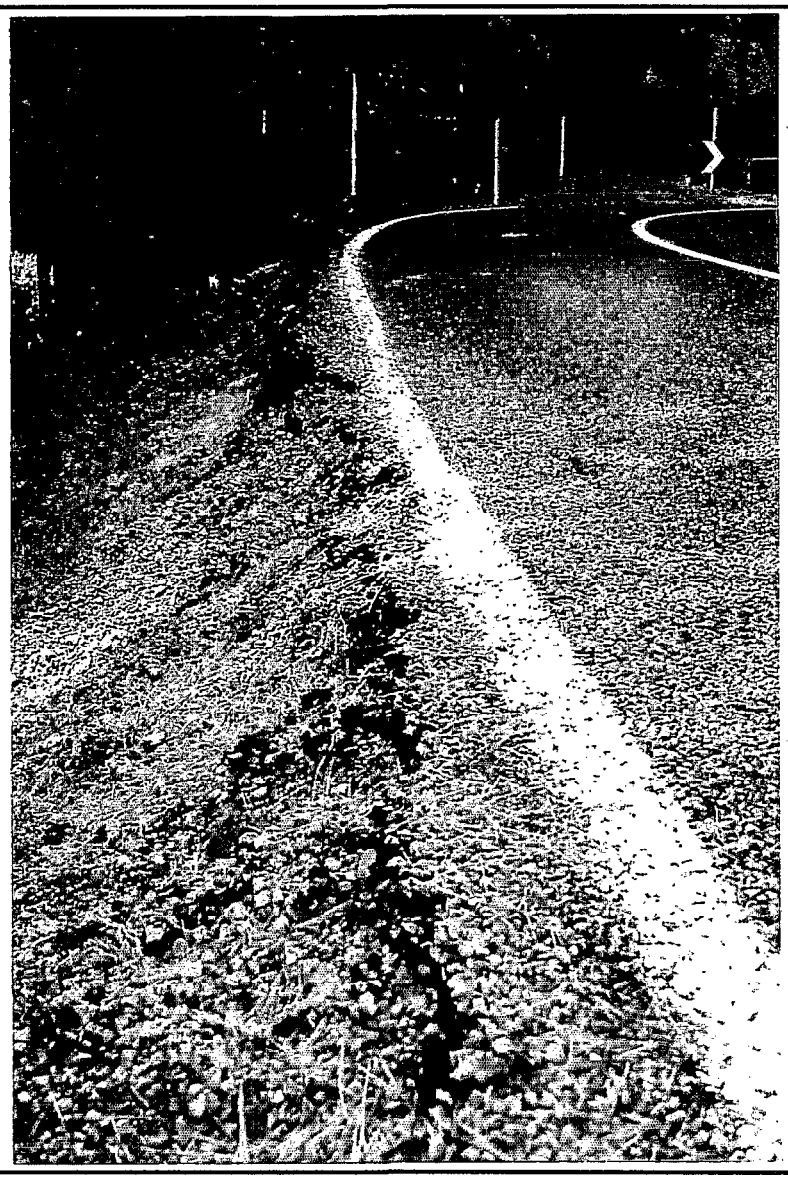

PHOTO 1 - STEEP FEATHER EDGE SLOPE
Note lack of edge support, edge break occurring, edge line too close to edge of seal

4.8 Feather Edge Slopes

Ideally a feather edge of 5 to 1 should be provided to allow vehicles to safety pull over off the seal. However, it is accepted that for seal extensions with low traffic volumes this is often unrealistic. (Refer photo 1 on page 22).

4.9 Sight Distance

Very few sight distance improvements were included in the projects inspected. In some cases the costs of providing additional sight distance was prohibitive and the compromise accepted by the team, in others the costs appeared to be relatively low. Where costs were low, it was not clear if the opportunity was overlooked or if there was a reluctance to take land.

PHOTO 2 - SUB-STANDARD SIGHT DISTANCE
Note height of batter and minimal cost of improvements

Of those sight benches constructed not all were well designed. One project had a significant sight bench which had been cut in a straight line across the inside of a tight curve with a very large deviation angle. The sight bench had not been designed to provide drivers with advance warning of tightness/extent of the

curve. Rather, the full extent of the curve is 'suddenly' revealed when drivers arrive almost at the start of the curve itself.

The practice of using kerb and channel to reduce cut quantities by eliminating the side drain was also encountered. This effectively reduces the available sight distance on horizontal curves unless adequate benches are constructed behind the kerbs.

Recommendations

That Transfund require scheme assessments to adequately consider sight distance improvements. If accident savings are claimed these must be based on an accurate assessment of future safety costs which should reflect the provision of (or lack of) appropriate sight distance standards.

4.10 Intersections/Access Ways

The site inspections revealed a number of safety deficiencies related to intersections and access ways. Most deficiencies could be eliminated or reduced by low cost measures.

Photo 3 on page 25 shows one project where the main route turned to the left and the side road to the right. The roads in both directions were concealed and tyre marks suggested to drivers that the main route was to the right. The intersection finger boards were hidden by trees and not visible until almost at the intersection.

Another intersection on another project had been squared up and slightly relocated to improve turning radii and as a consequence the already sub-standard sight distance had been further reduced.

Many access ways had sub-standard sight distance which could have been significantly improved by minimal earthworks or the removal of vegetation.

No side road junction advance warning signs were installed on concealed intersections or intersections with poor sight distance.

Recommendation

That Transfund require all designs to comply with good practice/approved standards and guidelines. Additional attention must be given to intersections and access ways at both design, construction and post construction stage. This issue is discussed further in Section 3.5: Post Construction Safety Audits and Section 3.6: Standards.

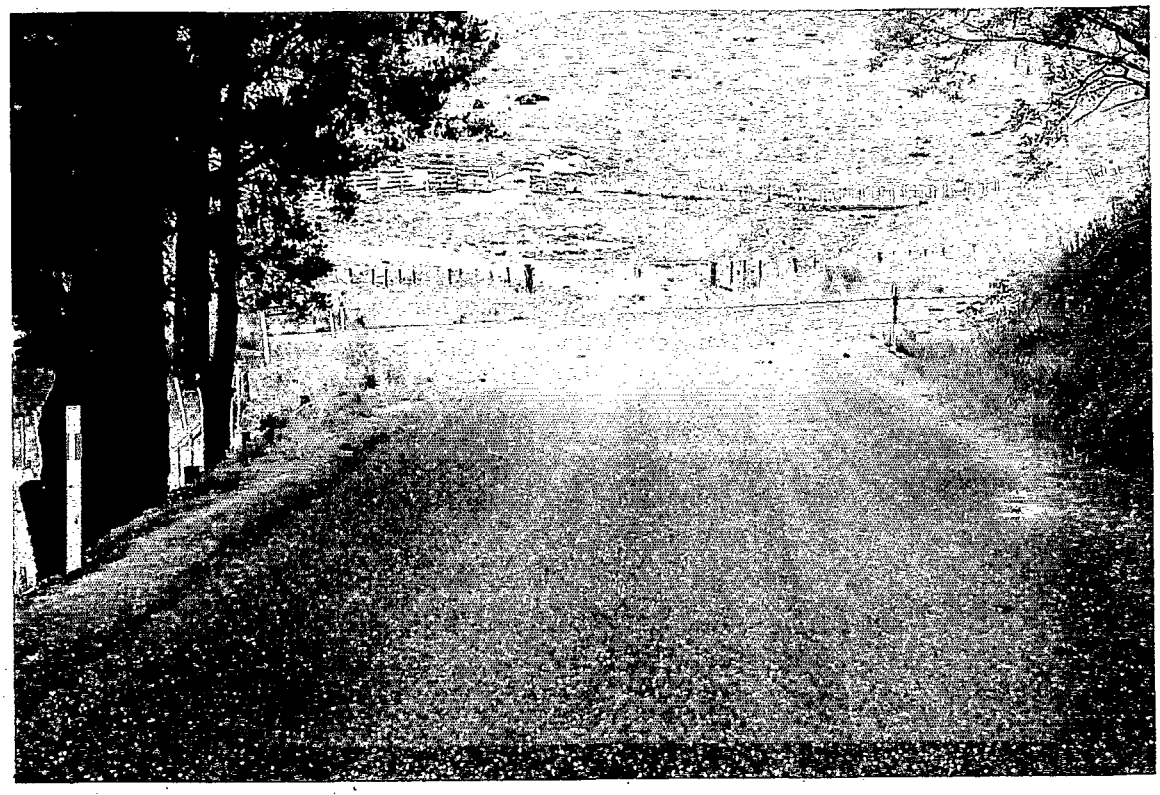

PHOTO 3 - INTERSECTION DELINEATION/MARKINGS
Both roads are concealed and the tyre marks suggest that the main route is to the right (the main route is to the left).

4.12 Passing Bays

One project inspected had significant lengths of 4.5m seal width (effectively one lane) and substandard sight distance. Only one small passing bay (with no signage) was provided in one direction. The inadequate provision of passing bays was considered to be a safety problem.

Recommendation

That Transfund require scheme assessments to adequately consider passing opportunities. Where the seal width is continuously below that required for two lanes, passing bays should be provided at regular intervals. The interval should be assessed relative to the construction costs and the traffic volumes.

4.13 Retaining Walls

Several retaining walls were poorly constructed and failures had or were occurring. Some obviously had not been designed for the height to which they had been constructed. Also a high proportion were not part of the original project but appeared to be required as a result of inadequate investigations/ poor design.

Recommendation

That Transfund require scheme assessments/final designs adequately investigate the need for retaining walls. Road Controlling Authorities must ensure that retaining walls are properly designed and the design height is not exceeded. See also Section 3.3: Scheme Assessments.

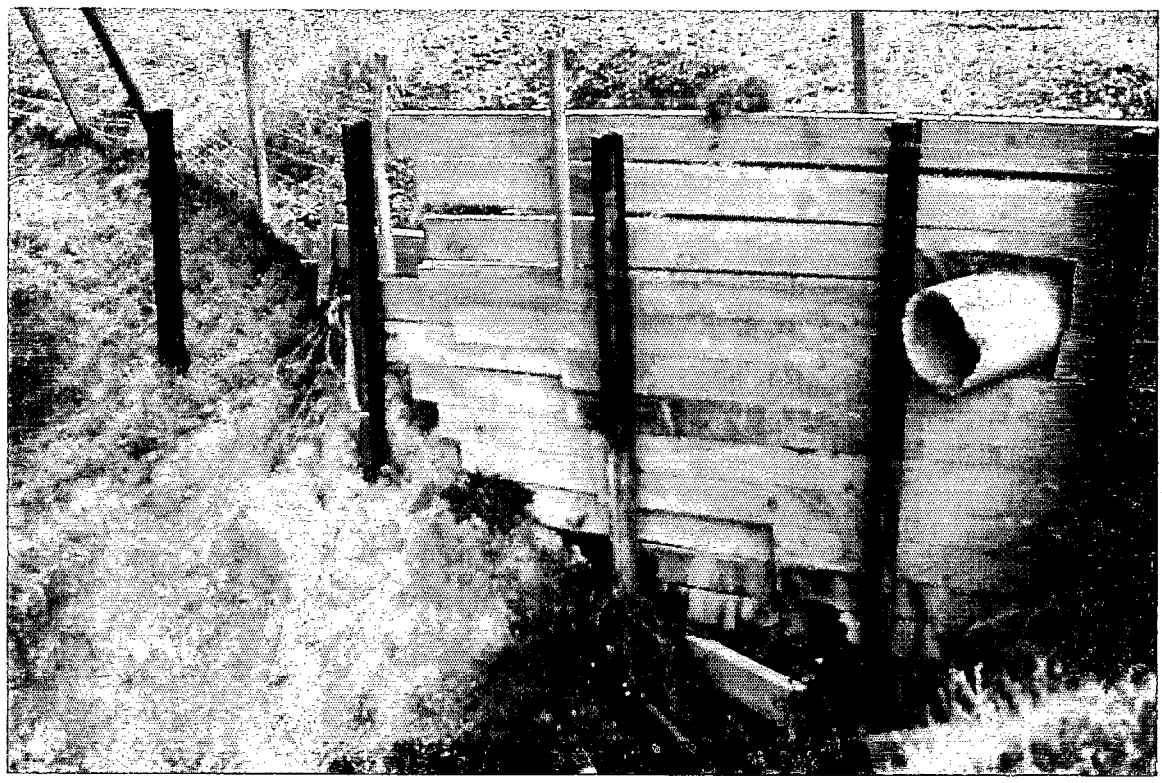

PHOTO 4 - RETAINING WALLS
Note the poor design / construction - the uprights have moved significantly and the wall is failing.

4.14 Signs

Of the seal extensions inspected only very limited number of signs had been installed and it appeared the provision of advisory signs had been given insufficient consideration. There was particular concern at the lack of curve signs on long horizontal curves which had inadequate sight distance and design speeds well below that of the adjacent curves. Most other common sign problems also involved horizontal curves. The team noted a lack of advisory speeds plates, poorly located signs, inadequate sizes and signs obscured by vegetation.

Recommendation

That Transfund require Road Controlling Authorities to ensure that adequate consideration is given to signs. This issue is covered in Section 3.5 Post Construction Safety Audits and Section 3.6: Standards.

PHOTO 5 - SIGNS
Note: The curve in the background is very tight and has a very large deviation angle. The curve sign is hidden by vegetation and has no advisory speed.

4.15 Road Marking

Most RCA's have made some attempt to comply with RTS5 . However, on one project inspected the installation of edge line and centre line markings were in complete conflict with RTS5 .

The project seal width was generally 4.6m with localised narrowing to 3.7m and extra widening on horizontal curves. Lanes were marked as narrow as 1.5m. The centre line markings were inconsistent with some sections dashed, some solid and others with no centre line. Some solid centre line markings covered a previously dashed centre line. The philosophy behind these markings was unclear and almost the reverse of the RTS5 Guidelines. It was also noted that the standards differed significantly on the adjoining sections with no two sections the same.

PHOTO 6 - NON STANDARD LINE MARKING
Note the seal width is too narrow for lanes lines. One lane measured 1.5m in width.

PHOTO 6A - LINE MARKING
Note edge line is painted over the roll-over.

Other common problems identified were:

- edge lines marked over the rollover where they cannot be seen and therefore do not provide adequate guidance
- one lane bridge advance warning not painted on the seal
- edge lines painted too close to the edge of seal where the feather edge has been steepened and does not provide adequate edge support

- centre lines not marked at the centre of the seal on tight horizontal curves and as a consequence trucks tracked over the centre lines

However, the cause for most concern was **general lack of consistency** of road marking in the sample of seal extensions.

Recommendation

That Transfund require all Road Controlling Authorities to generally adhere to national standards for road marking. This issue is discussed further in Section 3.6: Standards.

4.16 Delineation

4.16.1 General

The level of delineation on the seal extensions inspected varied greatly. The issues relating to various forms of delineation are discussed below.

4.16.2 Marker Posts

As with pavement markings most RCA's have made some attempt to install marker posts in accordance with RTS5 (for the traffic volumes on roads inspected the guideline generally requires either partial or full marker post installation to the old State Highway standard - refer to para 6.2.1 in RTS5). However, there was one significant exception to this. Based on the justification that there is an extremely high 'loss' rate in their part of the country, one Local Authority does not use marker posts at all.

Common marker post problems identified were:

- marker posts missing (this caused considerable concern as the old state highway standard provides only a limited number marker posts and frequently the marker posts missing were the most critical)
- others had the wrong reflectors (mainly white instead of yellow)
- where marker posts had been installed to the new standard there was concern that on the tighter radius curves the spacing between posts was too great (especially where the sight distance around curves was restricted).

PHOTO 7 - MARKER POSTS
Note there is little indication of the forward direction of the road.

4.16.3 RRPM's

Although not a requirement of RTS5 a few sites had RRPM's installed. However, in many cases they were missing on the tightest curves where the traffic obviously crossed the centre line and many others required replacing.

4.16.4 Hazard Markers

Almost no use was made of hazard markers. In many locations where one would expect to find hazard markers such as culvert end walls, potential dropout sites etc marker posts had been installed. This gives completely the wrong message to the motorist, especially at night.

PHOTO 8 - HAZARD MARKERS
Note use of culvert marker where hazard marker appropriate.

4.16.5 Chevron Boards

Many chevron boards were two bar chevron rather than standard four bar.